

Gravitation" is correct; but the kilogramme weight remains the same throughout the universe.

But if a balance could be constructed with its fulcrum somewhere in the Azores, and the scale pans hanging over Paris and Washington, then 1 kilogramme at Paris would equilibrate 1.00092 kilogramme at Washington (p. 286).

It is sometimes asserted in our school-books on Mechanics that a pound weight, if carried to the surface of the Sun, would weigh about 30 pounds; but if a balance could be made to stretch between the surfaces of the Earth and of the Sun, then a pound weight at the Sun's end would be equilibrated by 30 pounds at our end; so that it is equally true to say that a pound weight on the Sun will weigh 30 pounds on the Earth.

Prof. Mach would perform a great service if he would extend his criticisms on the usage of the word *pondus* by Huygens, Leibnitz, Wallis, &c., to modern times, as great mystifications exist at the present day.

The C.G.S. system of units is explained by Mr. Pierce on p. 285. These units are much too minute except for recording delicate physical measurement. If Prof. Johnstone Stoney's amendment of the M.K.S. (metre-kilogramme-second) system had been adopted, we should have a system incorporating the joule, watt, volt, ohm, and ampère as units; it is not too late to make the change; the disadvantage that the density of water is 1000 in this system is more apparent than real.

Although the double system of natural laws mentioned by Rankine is now exploded, we still have a double system of instruction in mechanical text-books, one theoretical, geometrical, rational; the other practical, mechanical, empirical, discoverable by experience. It should be the object of modern science to break down the barriers between these two systems, and to treat the subject of mechanics from one point of view. Instead of this, the gap between the two systems seems to be an increasing one, insomuch that Prof. A. B. W. Kennedy, in his inaugural address to Section G of the British Association at Oxford, demanded for young engineers a course of instruction in mathematics entirely different to that imparted at present in our schools and colleges.

Some remarks at the end of Prof. Klein's Sixth "Evanston Colloquium" may be consulted as bearing on this question.

A careful study of Prof. Mach's work, and a treatment with more experimental illustration, on the lines laid down in the interesting diagrams of his Science of Mechanics, will do much to revivify theoretical Mechanical Science, as developed from the elements by rigorous logical treatment.

A. G. GREENHILL.

NEWTN'S INORGANIC CHEMISTRY.

A Text-book of Inorganic Chemistry. By G. S. Newth, F.I.C., F.C.S. Pp. xiii. 667. (London: Longmans, Green, and Co., 1894.)

THE author states in the preface, that the arrangement of the course of elementary instruction in chemistry, which is given in this book, is based on the periodic classification of the elements. The properties of four elements, *hydrogen, oxygen, nitrogen, and carbon*, and the properties of many compounds of these elements,

are considered before the systematic study is entered on, of the groups into which the elements are divided by the application of the periodic law. Then follow chapters wherein the members of the various groups of elements, and the chief compounds of these elements, are described. To this descriptive part of the book are prefixed fifteen chapters of "introductory outlines," constituting "a brief sketch of the fundamental principles and theories upon which the science of modern chemistry is built." In his directions to students using the book, the author says that a start should be made by reading carefully the chapters dealing with chemical change, elements and compounds, nomenclature, and symbols; that the four typical elements—hydrogen, oxygen, nitrogen, and carbon—should then be studied; and that, as this study is proceeding, the remaining chapters of the "introductory outlines" should be mastered.

It seems to me that the method of the author is radically wrong. Descriptive statements of facts ought, surely, neither to precede, nor to follow, but to accompany, the reasoning on these facts whereby general principles are gained.

The author's treatment of chemistry implies that "the science of modern chemistry is built" on the foundation of such generalisations as those stated in his "introductory outlines," and that detailed descriptions of the properties of certain kinds of matter called elements and compounds constitute the science that is raised on this foundation. Would it not be more advisable so to treat the subject as to show that chemistry rests on certain definite natural facts, but that only when these facts are compared, contrasted, and classified, does a scientific knowledge of them begin?

The descriptions in this book of the members of each group of elements seem to me to be exceedingly well done; many portions of the chapters treating of principles and theories, notably the pages which deal with the laws of chemical combination, are admirable; nevertheless the book, as a whole, gives the impression of being unscientific. The method of the book tends, in my opinion, to perpetuate the vicious and unreal distinction between chemistry and chemical philosophy, a distinction that has probably been as potent as any other cause in stopping the progress of the science.

The purely descriptive portions of this work are often extremely good, as far as they go. The facts, or rather half-facts, are stated in a clear and orderly way; care is taken to notice recent work of importance; the woodcuts are well executed; but, all this is only the material out of which chemistry is constructed.

About 130 pages are devoted to statements of the properties of four typical elements—hydrogen, oxygen, nitrogen, and carbon—and of the properties of many compounds of these elements. But hydrogen, oxygen, nitrogen, and carbon are not treated as typical elements they are not compared and contrasted with other elements. After reading the descriptions of these elements and their compounds, and studying the properties of the elements in each of the eight groups of the periodic classification, one still feels unsatisfied. Something is lacking. Surely some fair and fitly fashioned building ought to rise on this broad superstructure. If chemistry is to be treated as a recitation of disconnected, or arti-

cially connected, facts, it ceases to be a subject worthy the serious attention of educated men. One turns to a new book on elementary chemistry, hoping to find at least an attempt to rescue chemistry from the overwhelming burden of so-called facts, beneath which the science is in danger of being buried. In this case I confess to disappointment. It may be replied that the chemistry which is not clearly apparent in the purely descriptive parts of the book is to be found in the "introductory outlines" wherein the "fundamental principles and theories" of the science are stated. I admit at once that there is much excellent matter in these earlier chapters; but I do not find there a connected setting forth of elementary principles, as arising from facts, and binding facts into some kind of harmonious whole. There is not much either exact or imaginative treatment; and these two I take to be the notes of genuine science.

The perusal of this book produces in one's mind a strange feeling of inversion; many things seem to be standing on their heads. The reader feels that a rapid mental rotation, to right or left, is demanded. Change is very properly said to be the feature of all chemical occurrences; but at a very early stage (p. 5), after two pages have been occupied in lightly touching the subject of the constitution of matter, the student is told that "Any change which arises from an alteration in the structure of the molecule is a chemical change." This is an example of the topsy-turviness of parts of the book. The statement quoted has a meaning when the meaning of such a very symbolical expression as "structure of the molecule" has been adequately grasped. At this stage of progress the student cannot have any clear image called up in his mind by the words I have quoted; they must be merely words to him. But he might have grasped the prominent and characteristic features of chemical change had these been put before him by well-chosen experiments. Another instance, to my thinking a glaring instance, of putting theory where facts should come, and facts where theory, is found in chapter ii., which deals with elements and compounds. The distinction between these classes of substances is stated at once, and is stated only, in the language of atoms and molecules.

"In the substance sulphur, all the atoms composing the molecules are alike; while in water . . . there are two distinct kinds of atoms in the molecule. Matter, therefore, is divided into two classes, according as to whether its molecules are composed of similar or of dissimilar atoms. Molecules consisting of atoms of the same kind are termed *elementary molecules*, and substances whose molecules are so constituted are known as elements."

The chapter which deals, and deals in a clear and most praiseworthy style, with the laws of chemical combination, is headed "The Atomic Theory." I think the author must have taken his own words too literally (p. 29):

"Dalton embraced the ancient doctrine of atoms, and extended it into the scientific theory which is to-day known as Dalton's atomic theory, and is accepted as a *fundamental creed* by modern chemists." (The italics are mine.)

A "scientific theory" and a "fundamental creed" are very different things.

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For his descriptive treatment of the materials from which chemistry is built up, I think the author is to be praised; but I do not think he has succeeded in setting forth the principles of the science of chemistry clearly, adequately, or in fitting order.

M. M. PATTISON MUIR.

OUR BOOK SHELF.

Astronomia Sferica. An Elementary Treatise. By Francesco Porro. (Roma: Società Editrice Dante Alighieri, 1894.)

IN these 160 pages, the author has endeavoured with success to bring before his readers, in as simple a way as is consistent with the subject, the elements of spherical astronomy. With the exception of a small knowledge of the rudiments of the differential calculus, the mathematical ability is by no means taxed. The order in which the subject-matter has been arranged, and the field which is covered, can be gathered from the following short summary. After dealing first with the sphere generally, and the form and daily motion of the earth, the annual motion round the sun, and the methods of the transformation of coordinates, the measurement of time is next explained, in which Kepler's equation, the equation of time, and the transformation of mean into sidereal time, and *vice versa*, are discussed. Then follows a chapter in which the movements of the moon are clearly expounded.

Diurnal parallax and refraction, the variations of the fundamental planes, aberration and annual parallax, form the subjects for the next three chapters; while the remaining ones are devoted to the determination of the positions of stars and their proper motion, and to the solar system in general. In the last-named, the apparent movements of the planets, the theories of Copernicus and Kepler, the necessary data for the determination of planets' orbits, &c., are touched upon.

From the above it will be seen that the most necessary points for the student have been dealt with, but they have not been treated at too great a length. As an introduction to higher works, this book will be found most useful; but its use in this country will be to a great extent restricted, owing to it being printed in Italian.

The New Technical Educator. Vol. iv. (London, Paris, and Melbourne: Cassell and Co., 1894.)

THE previous volumes of this work have been duly noted in our pages. Volume iv. is in every way up to their standard of excellence.

The subject of the manufacture of iron and steel occupies the first part of the volume. The author of this seems to be well acquainted with the practical details. We note that he appears to consider that the presence of but 0.05 per cent. of sulphur in steel is more or less harmful, producing a metal sensibly red-short. This may be the case; but it is generally considered that the percentages of phosphorus, sulphur, or silicon must not each exceed 0.06 per cent., and then their effects may be overlooked in axles, tyres, plates, &c. Engine-tyres are said to give a tensile test of 46 tons per square inch, with a minimum elongation of 20 per cent. in a 3-inch length. These results are rather extreme, with a sectional area of $\frac{1}{2}$ square inch of test-piece. If the extension exceeds 16 per cent. the result may be considered good with this tonnage.

As in previous volumes, we find much interesting information on cutting tools, from the pen of Prof. R. H. Smith, dealing principally with lathes, drills, and punching and shearing machinery. Different metal shavings are illustrated from photographs, and clearly show the nature of the different metals. The steel shavings shown,